





Plastic gloves

· Face masks Wiping robot with disinfectant

5. While testing for microbes, prepare additional plates that will not be inoculated to use as experiment controls.

Assessment

 Review student team presentations about their robots and how successful the robots are at

for ensuring robots destined to Mars and other worlds are sterile. Have them take apart and reassemble their robot using sterile procedures. First, have teams sterilize the components with disinfectant wines. Teams should wear disposable gloves and paper face masks. When the robots have been reassembled, have students repeat the swab and culture plate test. Are the results the same

at the following sites: http://www.nasa.gov/centers/johnson/slsd/ about/divisions/hefd/facilities/space-food.html

Extensions

by microbes?

dentists, etc.).

building_curiosity.html

· Learn about microbes on Earth. How do

. Investigate how we learn about microhes

procedures (food production, hospitals,

Discuss other applications for sterile

about bacteria and viruses?

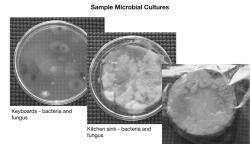
What kind of microscopes are used to learn

Learn about NASA food labs and clean rooms

http://www.nasa.gov/mission_pages/msl/

microbes help us? What diseases are caused

performing their tasks. Have students write a step-by-step procedure



Always Wash Your End Effectors!

Quick Look

Student teams will construct robots to perform a simulated food handling task on a future mission to the planet Mars. After demonstrating their designs, teams will be presented with a surprise challenge. They will check their robots for microbes using sterile culture plates.

Objectives

- Design and assemble a robot to perform a specific task using commercial robot kits or construct a simulated robot using various scrap materials. Demonstrate the robot in a simulated food.
- handling activity. Sample and analyze the surfaces of the robot
- for possible microbe contamination using sterile cultures.

Background

Student Names:

Name your robot:

Task your robot will perform:

Describe how your robot will work:

What ways can you change your robot to improve it?

You've heard about the importance of washing your hands, but washing your end effectors? What's that about? Actually, it's pretty much the same thing. An end effector is the robot term for

Why is it important to keep the end effector clean? The answer is microbes. A microbe is an organism consisting of a single cell or of a small cluster of cells. Microbes are usually too small to be seen with the naked eye. Microbes include bacteria, fungi, protists (protozoa, algae), and viruses,

There are far more microbes on planet Earth than all the other life forms put together. Take you, for example. There are more microbes living inside your body and on your skin than you have cells in your body. These microbes help digest our food, protect us from disease, and a whole bunch of other necessary processes that keep our bodies functioning and healthy. We use microbes to make cheese and yogurt, and microbes cause bread to rise. On a planet scale. microbes produce most of the oxygen we need

and recycle dead animal and plant matter.

Microbes are a powerful force on Earth. But then, there is the dark side of the force. There are nasty microbes responsible for diseases like malaria, cholera, influenza, colds and so on. That's where we get back to washing end effectors. Robots are used in a big way to process the food we eat. For example, you don't think a bunch of people are lined up with funnels putting ketchup into bottles! Robots do the job. They squirt the ketchup in the bottles, attach the safety seal, screw on the cap, stick on the label, and load the bottles in the cartons. Those robots have to be super clean, or the ketchup could be infected with bad microbes.

When it comes to space food, being super clean is important. If an astronaut on the way to Mars gets sick from a spoiled can of tuna, a trip to the emergency room is out of the question.

There is another reason for being super clean when exploring space. NASA has sent many robot spacecraft to the surface of Mars to try to answer the question, "Is there life on Mars?" There have been lots of discoveries that hint that life on Mars is possible but no actual life has been found yet. Wouldn't it be terrible if life is discovered on Mars and it turns out to be microbes that hitched a ride from Earth?

To prevent infecting Mars with Earth

microbes, technicians at NASA go to great



Technicians preparing the Mars Opportunity Rover in a clean room. Every care is taken to avoid contaminating the robot with stray objects or microbes.

Design and Build a Mars Food Production Robot

Preliminary Sketch of Your Robot

lengths to sterilize robots and encase them in a protective shell to keep hitchhikers out!

We learned about one possible strategy for future Mars missions in the "Mars Needs Food!" activity: Send robots to Mars to grow and store oodles of food in preparation for the arrival of the astronauts. Making sure the food is not contaminated by harmful microbes is also

Materials

 Robot kits for each team (LEGO®) MINDSTORMS®, VEX® Robotic Design System, LEGO® Education TETRIX®, LEGO® WeDo™

- Various scrap materials (if robotic kits are not) available) such as
- Cardboard tubes
- · Empty water bottles
- PVC pipe parts Plastic food containers
- Aluminum foil
- Binder clips Rubber bands
- · Prepared "culture plates" petri dishes with agar or baking potato slices and zip locking sandwich bags. See note about preparing culture plates.
- Cotton swabs (place two in a plastic bag to make distribution easier and reduce the chance of contaminating them) or packaged sterile swabs. Distilled water
- Bleach solution (about 10% bleach, 90%) water)
- · Latex, latex-free or vinvl exam gloves Disposable face masks

Preparing culture plates

The second part of this activity involves the search for microbes. As students assemble and program their robots or create model robots, they will naturally handle, breathe, cough, and sneeze on them. In doing so, they will deposit microbes on their surfaces. It is for a similar reason that many stores place wipes for customers to clean the handles of shopping

Using sterile procedures (described later) students will swab the surfaces of their creations and transfer some of the microbes to a growth medium. The growth medium will either be agar, a seaweed product, or slices of potato. If using agar, ready-to-use plates are available from school science suppliers. If desired, bottled again and petri dishes can be purchased separately. If doing so, follow the instructions for preparing the

A low-cost alternative to agar plates is 1/4- to 3/8-inch-thick slices of potatoes that have been boiled until nearly cooked. Boiling sterilizes the potatoes. Using a sterile knife, slice the potatoes. Ideally, the slices can be placed in petri dishes instead of agar. The dishes have lids that make them very convenient to use. Otherwise, the slices are placed in zip locking sandwich bags after being inoculated.

It is essential not to touch the slices (or the surface of agar) or breathe on them. Have the petri dishes or potatoes ready on the day the robots are completed. It is not necessary to have an incubator. The culture plates will do just fine at room temperature.

Special Note: Careful handling of the culture plates is important. The object is to capture microbes that have taken up residence on the outside of the robots student teams construct Once enclosed, the agar or potato slices should not be opened to avoid adding new microbes. When the activity is completed, the cultures should be disposed of. Traditionally, laboratories will use a disinfecting agent to destroy the cultures. If you wish to follow proper lab procedures, pour a bleach solution into each petri dish or sandwich bag, reseal, and dispose in a tied plastic garbage bag.

Procedure - Building robots

- Hold a class discussion on how a future human mission to Mars might be preceded by robots that set up greenhouses, grow food, and prepare for the arrival of astronauts.
 - · A human mission to Mars could take two
 - years.

 How much food and water will a crew of six or more need? (See discussion in the

"Mars Needs Food!" activity.) . Discuss the care NASA takes to prevent sending microbes to Mars and other worlds, and the diligence that it takes to ensure astronaut food is safe. Explain what microbes are and ask, "Are your

robots carrying microbes? 2. Challenge teams of students to design a robot to perform a food-growing or foodpreparation task that could be done on Mars

Possible Robot Challenges

Have student teams determine what particular food production task their robot is designed to perform. The following are just a few ideas to spark the imagination:

- Seed planting robot Irrigation robot
- Harvesting robot
 Crop transport (to storage) robot Cooking pot stirring robot
- · Water glass filling robot

It is not necessary to work with actual food when teams demonstrate their robots. For example, a CD can be used as a simulated pancake for a pancake flipping robot.

Check these sites for additional ideas http://robotics.nasa.gov/archive/robot

http://www-robotics.jpl.nasa.gov



Teams should begin by selecting a particular task for the robot. See the list of Possible Robot Challenges for ideas. The robot should do one task well 3. If students are already familiar with the robot kits you have available turn them loose Otherwise, have the teams work with the robots for a class period or two to learn their capabilities. Then, turn them loose. Or, have students construct a model robot from the scrap materials available and other materials

A factory robot puts bread onto pallets. Image @ 2011 by

students might bring from home. While their robots will be unpowered, parts such as arms and end effectors (grippers) should be movable. 4. When all robots or robot models are ready hold an exposition for the class and have each

team explain the purpose of their robot and demonstrate how well it completes its task.

Procedure - Checking for microbes 1. Discuss the care NASA takes to prevent sending microbes to Mars and other worlds

- Explain what microbes are and ask, "Are your robots carrying microbes?"

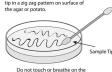
 2. Have student teams swab the surface of their robots in several places with cotton swabs and use the swabs to inoculate the culture
- Observe the culture plates daily for a week or
- 4. When plates begin showing colonies of microbes, hold a class discussion on possible strategies to keep Mars robots sterile. · Hand washing

Sampling Your Robot for Microbes

- 1. Carefully read and follow all directions in order to swab and culture microorganisms from the surface of your robot. Be sure to review the diagram below before inoculating your culture
- 2. Pick several areas on your robot for sample taking that you and your team touched during assembly.
- 3. Carefully remove one swab from the plastic bag. Only handle one end of the swab. If you accidentally touch both ends, dispose of the swab and use another.
- 4. Lightly moisten the sample tip of the swab with distilled water.
- 5. Rub the tip over the areas you chose for sampling.
- 6. Immediately rub the same tip in a zigzag pattern over the agar or potato surface. Cover the agar or potato and mark the cultured plate to identify it and the places sampled on your robot.
- 8. Set the plate in the designated place and examine it every day for a week or two.* Create a log book for your written observations and sketches (see example) At the end, write a summary of what happened.
- Note about using petri dishes: To avoid condensation dripping on to the agar surface, turn the plates upside down. Use a rubber band to secure the lid.

Innoculating a Culture Plate

After collecting samples from your robot, lightly rub the sample tip in a zig zag pattern on surface of the agar or potato.



swab sample tip or on the culture plate!

Log Book Example Log Page Sketch o photo of culture plate

20

Explore these websites for information on NASA missions and education resources:

NASA Home

www.nasa.gov NASA Education

International Space Station (ISS) www.nasa.gov/station

NASA Educator Resource Center Network (ERCN)

NASA Teaching From Space

NASA Digital Learning Network (DLN)

NASA TV

education.nasa.gov www.nasa.gov/multimedia/nasatv/

NASA Central Operations of Resources for Educators (CORE) core.nasa.gov

NASA Careers

www.nasa.gov/education/careers

NASA Food for Thought Curriculum http://Education.ssc.nasa.gov/foodforthought.asp

NASA Space Food Systems Laboratory (SFSL)

www.nasa.gov/centers/iohnson/slsd/about/divisions/hefd/facilities/snace-food.html